

Global environmental change and human health: a public health research agenda

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Research into the health effects of global environmental changes is important

Environmental problems, and our perceptions of their current and future health effects, have changed over the decades. About 20–40 years back, public health was most concerned about localised environmental degradation, as exemplified by air and water pollution. Although it was often difficult to measure the direct health effects, the paradigm of public health worked reasonably well to cope with these problems. As a result, some of the localised environmental problems of the 20th century have been solved, at least in the richer parts of the world.¹

We have since become aware, however, of the threats to human health which operate at a much larger geographical scale, and which, because of their non-localised character, are even more difficult to investigate. All these “global environmental changes” are due to increased human pressure on the environment, of which the main drivers are population growth and an increase in per capita resource use and waste production. Climate change and other changes to the atmosphere, land use changes and soil degradation, freshwater depletion and contamination, and biodiversity loss are four important categories of global environmental change, each of which form potential, although partly or largely unknown, threats to human health.² What should public health research do to help humanity cope with these new environmental problems?

WHAT IS KNOWN ALREADY?

A better understanding of the (potential) health effects of global environmental change is only just emerging, partly based on observations of current exposure–health outcome associations, partly based on scenario analyses, and in both cases surrounded by considerable uncertainty. These health effects are mediated by a number of causal pathways, of which the most important probably are heat waves and other extreme weather events,

changes in the spread of micro-organisms, changes in biological productivity of land and water, and pollution of air and water.³

It is beyond the scope of this paper to review these pathways, and therefore a few examples will have to suffice.

- Analyses of the population health effects of global warming suggest that global warming is already causing major health effects, mainly through heat-related mortality and morbidity and climate-induced changes in the incidence of infectious diseases. The largest part of this burden is shouldered by developing countries in Africa and South-East Asia—not by the countries in western Europe and North America, which have historically contributed most to greenhouse gas emissions.⁴
- A quarter of the Earth’s terrestrial surface is now used for human purposes, and deforestation, irrigation and other land use changes are often associated with changes in the spread of micro-organisms. Erosion, desertification and salinisation of fertile soils threaten the food production necessary for a rapidly increasing world population, of which a large part is already malnourished.⁵
- Human freshwater use for irrigation, drinking and household purposes exceeds the available supplies and requires withdrawal from groundwater stocks. Many populations already experience freshwater shortages, and the supply of safe water is further threatened by chemical pollution which has already reached the ends of the Earth.⁶
- Destruction of the habitats of other species, introduction by humans of non-native species, pollution of air, water and soil, and overharvesting by hunting and fishing have led to a massive extinction of plant and animal species. Biodiversity losses may

indirectly threaten human health by impairing “ecosystem services” such as regulation of infectious disease, pollination, waste removal and serving as a reservoir for new crops and medicines.⁷

Although some of the postulated health effects can already be empirically observed in some populations, most are conjectures with varying degrees of statistical certainty, theoretical justification and dependence on intervening developments.

Unfortunately, healthcare (including public health) has made, and is still making, major contributions to these global environmental changes. Hospitals consume large amounts of energy, water and materials, and hospital waste contributes substantially to air, water and soil pollution. A striking illustration is that medical care (eg, broken thermometers) is responsible for most of the mercury emissions into the environment. The “ecological footprint” of one Canadian hospital has been estimated to be >700 times its physical footprint.⁸ We must also become aware of the fact that the successful promotion of population health has contributed importantly to the rise in human population numbers, and all the environmental pressures this has generated. This rise has occurred in three great waves, of which the third took place around the middle of the 20th century. This was largely due to public health measures, such as improved water supply and waste removal, insect control, and vaccinations and antibiotics.⁹

The uncertainty inherent in analyses of the current and future health effects of global environmental change contrasts sharply with the relative certainty surrounding the health effects of localised environmental degradation that we read about in public health reports. For example, the most recent estimate of the National Institute for Public Health and the Environment in The Netherlands is that between 2% and 5% of the total burden of disease in this country (measured as loss of disability-adjusted life-years) is attributable to environmental problems, mainly air pollution (fine dust, ozone), in-house exposures (dampness, radon), noise (road traffic, air traffic) and food contamination (micro-organisms).¹⁰

As a guide to public health policy, however, this estimate has two important omissions. Firstly, it ignores the current health effects of environmental degradation caused by the Dutch population outside the boundaries of The Netherlands. The Netherlands is an open economy, and its living standards are highly dependent on imports and exports of food, materials, fuel and services. Like other rich countries, The Netherlands is a

Box 1: Research areas for the field of global environmental change and human health, with examples of research topics
Better understanding of the health effects of global environmental change

- Empirical studies of current health effects, taking advantage of circumstances (extreme weather events) and localities (environmental hotspots) where these effects already manifest themselves.
- Scenario analyses of future health effects, combining empirical data with theoretical insights and expert opinions on quantitative and qualitative modelling exercises.
- Integrated assessment analyses of current and future health effects, comparing different environmental changes to facilitate priority setting.

Adaptation to reduce the health effects of global environmental change

- Development of more effective methods for the health management of heat waves, floods and other extreme weather events.
- Development of more effective methods to control emerging infectious diseases, such as vector control, vaccination and pharmacological treatment.
- Development of diets that are nutritious, palatable and affordable, and do not require unsustainable food production and transportation methods.

Better understanding of the contribution of healthcare to global environmental change

- Assessing the environmental effect (footprinting) of healthcare (including public health) resource use and waste generation.
- Assessing the environmental effect of health care (including public health) through population growth, and the potential of health development to help slow population growth.

Mitigation of the contribution of healthcare to global environmental change

- Development of healthcare (including public health) practices that are sustainable in terms of resource use and waste generation.
- Development of a framework for (public) health ethics which incorporates sufficient degrees of international, intergenerational and interspecies equity.

net exporter of environmental problems which cause health problems in other populations.¹¹ Secondly, this estimate ignores the future health effects of environmental degradation caused by The Netherlands. Current environmental degradation is part of an accelerating process of resource depletion and waste accumulation, which may result in increasing effects on population health in the future.

We need a better guide to public health policy, but how can this be developed?

RESEARCH QUESTIONS

Box 1 lists a number of issues that could be answered by public health research, to allow public health institutions and professionals to better cope with these challenges. Four types of issue have been distinguished, and for each of these a number of examples have been mentioned. The list is limited to issues which can effectively be dealt with by public health research (other disciplines will have to take the lead to tackle the many other issues in this field).

The first two sets of issues relate to the health effects of the four global environmental changes mentioned above. There

is great need for a better qualitative and quantitative understanding of what these effects might be, and this requires both studies of current health effects and scenario analyses of likely future health effects. This should then inform priority setting for adaptation policies, but some of the major threats are already partly known, and we can therefore now start developing adaptation measures—for example, to cope with extreme weather events, emerging infectious diseases and the challenge of sustainable nutrition.

The third and fourth issues relate to the special responsibilities that health workers have for the environmental problems caused by healthcare activities (including public health). Both the direct effects (through resource consumption and waste generation) and the indirect effects (through population growth and other influences on economic production) should be investigated. We should also try to develop practices which are sustainable in resource use and waste generation, accepting that this might reduce our effectiveness or efficiency. An integration of bioethics with environmental ethics may be necessary to guide us in the trade-offs involved.¹²

Until recently, the study of the health effects of global environmental change remained largely outside the scope of public health research, because these research topics require an unusually high degree of multidisciplinary, the development of new research methods that can better deal with non-localised (indirect, delayed, multilevel) effects and a high tolerance for uncertainty which is at odds with conventional scientific attitudes.¹³ Only a few of the larger public health research centres around the world have formed dedicated groups working on these problems (Harvard Medical School: Harvard Center for Health and the Global Environment (<http://chge.med.harvard.edu/>); Johns Hopkins Bloomberg School of Public Health: Program on Health Effects of Global Environmental Change (<http://www.jhsph.edu/researchcenters/>); London School of Hygiene and Tropical Medicine: Centre on Global Change and Health (<http://www.lshtm.ac.uk/cgch/>)). The fact that an increasing number of studies are reaching the high-impact journals indicates that it is time for research into the health effects of global environmental change to enter the mainstream of public health research.

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THE JECH GALLERY

Money orders and alcohol yes; fruits, vegetables and skimmed milk no



Figure 1 Grocery store in Baltimore City, USA.

Neighbourhood socioeconomic characteristics are associated with differences in food intake after adjusting for individual characteristics.¹ Neighbourhood-level characteristics could contribute to ethnic and economic differences in dietary patterns. Systematic measurement of environmental variables is a challenge in epidemiology.²

In Baltimore, we are studying the effect of availability and price of food on cardiovascular risk by visiting 366 food stores in neighbourhoods of 1000 participants in a cardiovascular study.³

Within 1 mile of the grocery store (fig 1) reside 83 of the study participants. This store offers money orders, alcohol and lottery tickets, but no fruits or vegetables, no wholewheat bread and no skimmed milk. The price of milk, cereal and bread was 20% higher than that in the closest supermarket 1.7 miles away. This store is not an exception.

A poor diet resulting in obesity is a major factor in the epidemic of non-communicable diseases, which disproportionately affects the poor.⁴ Epidemiologists need to deal with this problem, if recommended diets based on fruits and vegetables, wholewheat bread, and low-fat dairy products are to be made available and affordable to both the high-risk and general populations.⁵

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